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MEASUREMENT OF THE ABSORPTION OF COSMIC RADIO EMISSION DURING THE SOLAR ECLIPSE OF 15 FEBRUARY 1961

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ABSTRACT

Presented are the results of measurements of cosmic radioemission in the ionosphere in the frequencies of 13, 18.6 and 25 mc/s according to observations conducted in Yevpatoria and Gor'kiy during the period of the February 15, 1961 solar eclipse.

Author

COVER-TO-COVER TRANSLATION

Up to the present time data on ionosphere behavior during solar eclipses were basically obtained by way of measurement of ionosphere critical frequencies and of absorption of ionosphere-reflected radiowaves [1, 2]. The development of the radioastronomical method of ionosphere investigations allowed its application in the present work for the determination of radiowave absorption in the ionosphere during a solar eclipse. One of the merits of the radioastronomical method is the possibility of o taining information ontthe variation of absorption in the whole ionosphere thickness, including the region above the F_2-layer maximum, which is inaccessible for pulse measurements.

At the same time, joint measurements by radioastronomical and pulse methods allow in principle the estimate of the contribution to the total absorption by regions above the F_2-layer maximum [3].

Observations conducted during the period of the solar eclipse of February 1961 in Yevpatoriya (Grimea) and Gor'kiy had the following assigned fixed frequencies : 25, 18.6 and 13 mc/s in Yevpatoria, and 25 and 13 mc/s in Gor'kiy. As far as we know, no similar observations were carried out during the preceding eclipses. The aim of the current observations consisted in detecting the effect of absorption decrease of cosmic radio emsision in the ionosphere, caused by the solar eclipse, and in attempts to differentiate the absorption by the ionosphere layers. Identical instrumentation was used in both, Evpatoriya and Gor'kiy during measurements at all frequencies. The receiving antennas consisted of six wave vibrators and had radiation patterns whose maxima were directed toward the zenith, while the width at the half-power level constituted 30°. The receiver-amplified signal was fed to a quadratic detector and the pulse noise limiter, and then it was registered by the self-recording device.

Because the zenithal angle of the Sun during the eclipse was substantially different from zero, the maximum eclipse phases were different at various altitudes. In Yevpatoriya, the ionosphere region, through which passed the received radio emission, was in the total eclipse conditions at the D-layer level. The portion of the ionosphere at the F-layer height was under conditions of partial eclipse with a maximal phase equal to 0.94. In Gor'kiy, the solar eclipse was partial in the F- as well as the D-layer, with maximal phases respectively equal to 0.86 and 0.92.

Observations were carried out in both, Gor'kiy and Yevpatoriya, during 10 — 12 days prior and after the eclipse. From the readouts obtained, those of five days were chosen, during which the course of ionosphere F_2-layer's critical frequencies differed

little from that of f_0F2 during the day of eclipse (the latter were obtained according to data of KrAO and NIRFI ionospheric stations), inasmuch as the daily variations of critical frequencies of the D- and E-layers have a more regular character, and are basically determined by the Sun's zenithal angle. Observations during control days allowed to determine with a sufficient degree of precision the course of the normal uneclipsed level of cosmic radio emission during eclipse hours, from which later the effect of eclipse was later read off. For Yevpatoriya the curve of cosmic radio emission distribution in the day of eclipse over portions prior and after eclipse coincided well with the average curve for control days.

During the day of eclipse the absorption was very weak in Gor'kiy by comparison with the control days, and the curve of distribution of radio emission coincided with the envelope of all the distribution curves of cosmic radio emission. The read off for the eclipse effect was carried out in that case from the envelope. The precision of the obtained data was determined by the scattering of control points for different days, and by random errors at finding the intensity of the received signal. The maximum error in the determination of absorption variation during the time of eclipse did not then exceed 0.1 db : In fact, it was less.

As a result of processing carried out according to the described method, obtained were curves characterizing the variation in the absorption of cosmic radio emission during the eclipse period.

In the Fig. 1 a next page plotted are the curves obtained through Observations in Yevpatoriya, and in the Fig. 1 . — the curve for Gor'kiy in the 13 mc/s frequency, representing the difference between the normal and the eclipsed absorption levels (the time being the Moscow time). The effect of the eclipse in the 25 mc/s frequency was not detected in Gor'kiy with a precision to experimental errors.

Compiled are in the Table the quantities of maximum absorption decrease, of maximum phases of eclipse at D and F-layer levels of the ionosphere, and the values of the cosines of Sun's zenithal angles for Yevpatoriya and Gor'kiy.

Place of Observations	Coordinates of the points of Observation		Sun's cosχ	$-\Delta\Gamma_{max}$ дб			Maximum Phase	
	φ	λ		13 mc/s	18.6	25 mc/s	D	F2
Yevpatoria	45°15'	2 h 13'	0.44	0.48	0.32	0.2	1	0.94
Gor'kiy	56°09'	2 h 57'	0.35	0.35	—	?	0.92	0.86

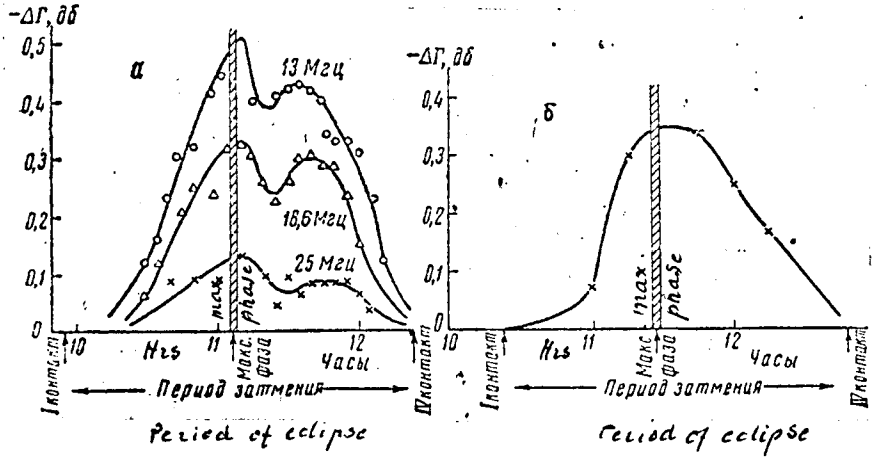

Fig. 1

Curves of Figures 1 a and б show that the maximum of absorption decrease is shifted by several minutes relative to the moment of the maximum phase of the eclipse. The magnitude of this retardation is close to relaxation time of processes in the ionosphere at the level of D-layer. For the curves obtained in Yevpatoriya (Fig. 1 a), the presence of a second maximum is characteristic, which is significantly smaller than the maximum

shifted relative to the first one by a time of the order of 30 min. The juxtaposition of the curves presented in Fig.1 a, with the map of the Sun for the period of eclipse has shown, that no visible formations of any kind were observed in the solar disk, that could explain the appearance of the second maximum in that period. It is most likely that the second maximum in the curves of Fig. 1 a is related to absorption variation in the F-layer, where the relaxation time is considerably greater than in the D-layer. In connection with that it is interesting to note that the minimum of the critical frequency f_0F2 for Moscow [3] and for Gor'kiy [4] is also displaced relative to the maximum variation of the critical frequency of the E-layer. In nearly coincides in time with the maximum phase of the eclipse.

The comparison of data obtained in Yevpatoriya and Gor'kiy shows that the ratio of maximum absorption variations approximately corresponds to that Sun's zenithal angles' cosines at indicated points. In our opinion, all this attests to the fact that during the period of eclipse of 15 February 1961 the variation of electron concentration at the D-layer level was basically responsible for the absorption variation (particularly at the moments of time close to the maximum phase of the eclipse). The presence of the second maximum on the curves of Fig. 1 a, which coincides in time with the minimum of the critical frequency of f_0F_2 apparently points to a certain variation of absorption during the period of eclipse and also in the F-layer.

FIG. 2

To estimate the relative magnitude of absorption variation during the eclipse by the two-frequency method [5], we computed the daily course of absorption for Yevpatoriya at frequencies of 13 and 18.6 mc/s. It is plotted in Fig. 2, according to which the maximum absorption decrease during the eclipse

period constituted only 20 ÷ 30 percent of the total absorption at that time (an analogus situation was observed in Gor'kiy).

If we assume that during the time of eclipse the absorption of the observed cosmic radio emission in the D-layer decreased to values near zero* , the obtained data permit the assumption that in usual conditions radiowave absorption in the F-layer is about three times greater than the value of absorption in the D-layer of the ionosphere. These results agree well with the conclusions reached in references [5, 6].

In conclusion, the author express their gratitude to G. G. Getmantsev for his assistance in carrying out the work, to the assistants having participated in the observations, and also to N. A. Savich for supplying data on the f_0F_2 critical frequencies in the Yevpatoriya region.

***** THE END *****

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References follow../..

* This can be entirely expected for Yevpatoriya, inasmuch as the eclipse was here total at the level of the D-layer of the ionosphere.

REFERENCES

1. K. RAWER. Absorption measurements for the eclipse of 30 June 1954. Solar eclipse at the ionosphere. page 102, Pergamon Press, London, 1956.

2. W. R. PIGGOTT. Absorption measurements during an eclipse. Solar eclipse at the ionosphere. Ibid. p. 106, London, 1956.

3. K. N. VASIL'YEV, A. S. VELESHIN, A. R. KOSENKOV. Geomagnetizm i Aeronomiya, I, No. 2, 277, 1961

4. V. A. VASIN, L. V. GRISHKEVICH. Ibid., I, No. 6, 949, 1961

5. E. A. BENEDIKTOV, Yu. S. KOROBKOV, N. A. MITYAKOV, V. O. RAPOPORT, L. N. KHODALEVA. Izv.V.uch.zav.Radiofizika, 3, 6, 1960

6. E. A. BENEDIKTOV, N. A. MITYAKOV. O pogloshchenii kosmicheskogo radioizlucheniya v ionosfere (On the absorption of cosmic radio emission in the ionosphere). Izv. Vysh.uch.zav."Radiofizika", 4, No.1, 44, 1961

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